SPECTRAL DOMAIN PARTITIONING FOR PARALLEL SCIENTIFIC COMPUTATION

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Abstract.
To harness the power of a massively parallel computer, the workload of an application program must be partitioned among the multiple processors. In order to achieve high performance, this division of labor must ensure that the computational load is balanced and the interprocessor communication is minimized. For applications with irregular grids or complicated geometries, a quality of the mapping of work to processors can have a dramatic impact on the runtime of the application. Unfortunately, finding the optimal mapping is NP-complete. We present an approach to this problem that generalizes recent work on spectral techniques for graph bisection. Our method allows for the division of a computation into four or eight pieces at each stage of a recursive decomposition, resulting in better decompositions and greater computational efficiency than previous techniques. We further improve the partitions by applying a fast, local optimization technique to the spectral output. This technique has been successfully applied to problems from a number of different applications areas including finite difference, finite element and particle in cell codes.

Key words. parallel computing, scientific computation, irregular grids, graph theory.